# Trends in Adolescent Suicide: Misclassification Bias?

*Beat Mohler, MD, MPH, and Felton Earls, MD*

A B S T R A C T

*Objectives.* This study investigated the effect of misclassification of accidental deaths and undetermined deaths on age-, sex-, and race/ethnicity-specific adolescent suicide rates from 1979 through 1994.

*Methods.* Official mortality data were used to present suicide mortality trends. Two estimates of misclassified suicides in other death categories were applied to calculate "corrected" trends of adolescent suicide.

*Results.* The corrected trends showed a downward adjustment for Black adolescent males and young adolescents. This result does not, however, substantially alter the trend toward a recent increase in suicide in these groups.

*Conclusions.* Despite misclassification, the true direction of trends in adolescent suicide is reflected in recent official data. However, suicide rates should continuously be tested for misclassification, mainly in populations with proportionately high accidental and undetermined death rates. (*Am J Public Health.* 2001;91:150–153)

Reports on suicide rates in the United States show a dramatic increase in rates for teenagers and young adults between 1950 and 1990.[1–4] This escalation is especially significant given the overall decrease in adolescent mortality since 1968, mainly due to reductions in accidental deaths.[2,3] Although White male teenagers had the greatest increase in suicide rates during the early decades of this trend, recent evidence indicates a marked increase in suicide in Black male teenagers.[5,6]

The accuracy of the death category "suicide" and the validity of official suicide rates have been questioned repeatedly. Suicides are misclassified through random error and nonrandom bias. The latter usually leads to underreporting because of missing suicide-specific information at death and because of various factors, such as insurance benefits and religious or social stigmas of suicide, that may directly or indirectly affect the coroner's decision.

Investigations of nonrandom misclassification of suicide show some disagreement on the importance of its effect in different subpopulations and on the most important death categories that include misclassified suicides. Earlier studies in Europe suggested that underreporting is constant over time.[7] Holding and Barraclough[8] investigated death categories potentially including misclassified suicides and found no difference between undetermined deaths and accidental deaths. More recent findings describe significant underreporting for females[9,10] and for immigrants and ethnic minorities.[11] In US populations, higher rates of underreporting have been found for Blacks[12,13] and for women.[14] Moyer et al.[14] concluded that a very high specificity exists for suicide, yet at least 10% of suicides were misclassified in other injury death categories.

When the new category "circumstances undetermined" was introduced in the transition from *International Classification of Diseases, 7th Revision* (*ICD-7*),[15] to *International Classification of Diseases, 8th Revision* (*ICD-8*),[16] a much steeper decrease in suicide rates occurred in Blacks compared with Whites.[12] In contrast, the recent increase in suicide rates in Californian adolescents is interpreted as the result of decreasing misclassification rather than a true increase.[17]

It is important to study the validity of using mortality data as health indicators for

Beat Mohler is with Harvard School of Public Health, Boston, Mass. Felton Earls is with Harvard Medical School, Boston, Mass.

Requests for reprints should be sent to Beat Mohler, MD, MPH, Department of Maternal and Child Health, Harvard School of Public Health, 677 Huntington Ave, Boston, MA 02115 (e-mail: bmohler@hsph.harvard.edu).

This brief was accepted April 20, 2000.

specific populations, especially when misclassification bias is a troublesome issue, as reflected in the example of suicide. As described in the literature, misclassification of suicide leads to underreporting of suicide, and changes in misclassification can affect suicide trends in different directions. Thus, officially reported specific mortality trends should be interpreted carefully. This applies especially to the US adolescent population, in whom unintentional injury, homicide, and suicide are the 3 leading causes of death, accounting for a significant proportion of mortality.[1–3] In this brief, we analyze and discuss the effect of misclassification on recently reported trends in adolescent suicide in the United States.

## Methods

We analyzed national mortality data for 1979 through 1994 from the National Center for Health Statistics. Raw and aggregated mortality data of Black and White adolescents from different age groups were used to estimate secular trends in suicide. Several investigations[8,9,11,13,14,17–20] described misclassification of suicide into categories of single-driver death, poisoning, and undetermined death. Phillips and Ruth[13] investigated mortality rates at symbolic (decennial) ages because people around their decennial ages are at a higher risk for suicide.

Mortality peaks were found not only for suicide (*International Classification of Diseases, 9th Revision* [*ICD-9*],[21] external-cause-of-injury codes [E-codes] 950–959) but also for undetermined injury death (*ICD-9* E-codes 980–989), single-car-driver death (*ICD-9* E-code 815), pedestrian death (*ICD-9* E-codes 814.7 and 805.2), accidental barbiturate poisoning (*ICD-9* E-code 980.1), and unknown and ill-defined diseases (*ICD-9* E-codes 780–799). The authors derived an estimate for misallocated suicides as percentage of aggregate mortality in these 5 suspect causes of death (i.e., 7.91% for Whites, 11.80% for Blacks; 6.31% for males, 11.04% for females).

Considering the significant differences in suicide and injury mortality rates by sex and race/ethnicity, we enhanced Phillips and Ruth's method.[13] Four sex- and race/ethnicity-specific proportion estimates of misclassified suicides in the aggregate mortality rate of the 5 suspect causes of death can be derived from equations that use the sex-to-race/ethnicity ratios of the population studied (1990 census youth and adolescent population, aged 10–24 years: males/females in Whites=0.52/0.48, in Blacks=0.50/0.50; Black/White in females=0.84/0.16, in males=0.85/0.15) and Phillips and Ruth's sex- and race/ethnicity-specific estimates. We derived the following proportions of misclassified suicides in the suspect causes of death: 18% for Black females, 11% for White females, 10% for Black males, and 6% for White males. Our first corrected estimate was calculated in age, sex, and race/ethnicity strata as the sum of the official suicide rate plus the sex- and race/ethnicity-specific portion of accidental and undetermined deaths (see above *ICD-9* categories).

To calculate a second corrected estimate, we followed suggestions made by other authors[10] and aggregated rates of suicides and undetermined deaths (crude sum of rates in both death categories). Percentage changes in the rates over the 15-year period were calculated on the basis of mean rates from 1979 to 1981 and from 1992 to 1994. To have statistical information on trends in estimated suicide rates between 1979 and 1994, we performed a linear regression on annual rates. The 95% confidence intervals (CIs) for percentage change in each sex and race/ethnicity stratum were calculated from the linear model.

## Results

Official suicide rates as reported in Figure 1 show marked differences by age, sex, and race/ethnicity. Independent of age and race/eth-

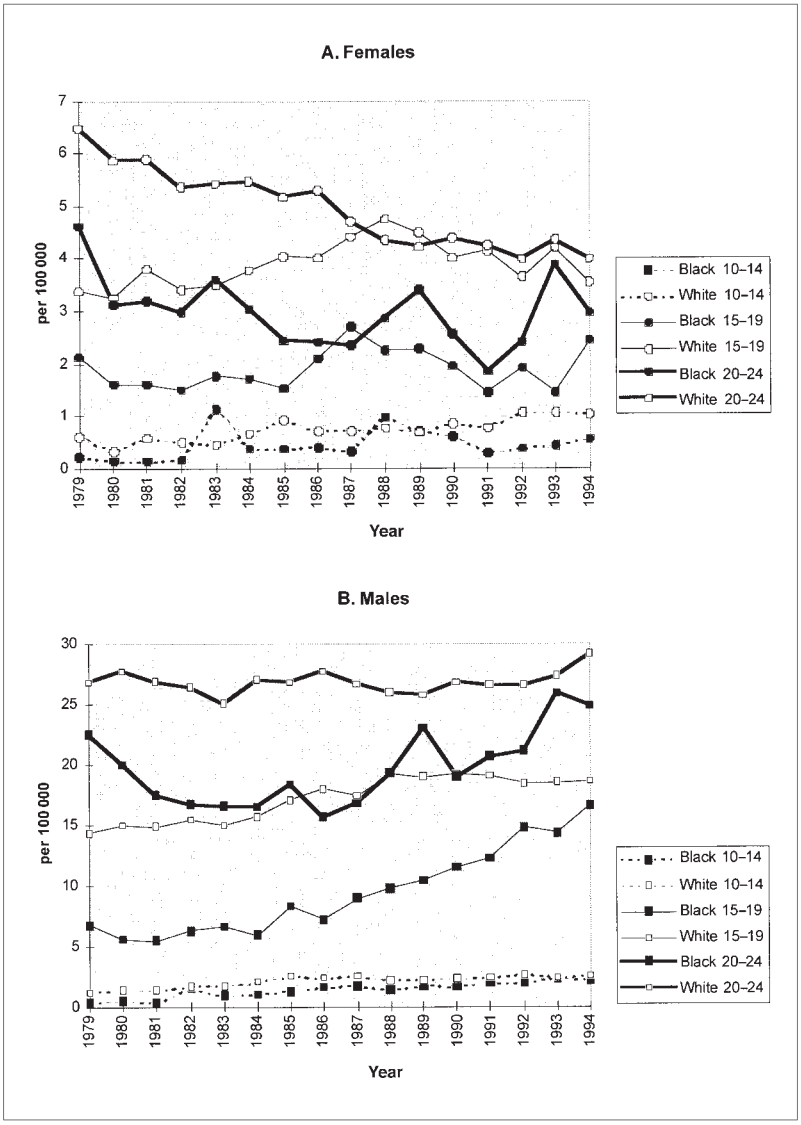


**FIGURE 1—Official suicide rates in females and males aged 10 to 24 years, 1979–1994.**

**TABLE 1—Official and Corrected Suicide Rates and Percentage Change: 1979–1981 to 1992–1994**

| | Mean Rate: 1979–1981 | | | Mean Rate: 1992–1994 | | | Percentage Change | | |
|---|---|---|---|---|---|---|---|---|---|
| | Official | Correction A[a] | Correction B[b] | Official | Correction A[a] | Correction B[b] | Official | Correction A[a] | Correction B[b] |
| Aged 10–14 y | | | | | | | | | |
| Black female | .16 | .52 | .41 | .45 | .85 | .61 | +181 (–72, +241) | +63 (–13, +132) | +49 (–63, +126) |
| White female | .50 | .56 | .65 | 1.04 | 1.10 | 1.09 | +108 (+69, +171) | +96 (+74, +161) | +68 (+45, +133) |
| Black male | .36 | .68 | .95 | 2.13 | 2.52 | 2.69 | +492 (+293, +482) | +271 (+188, +304) | +183 (+102, +201) |
| White male | 1.32 | 1.40 | 1.73 | 2.50 | 2.57 | 2.84 | +89 (+52, +114) | +84 (+50, +108) | +64 (+38, +85) |
| Aged 15–19 y | | | | | | | | | |
| Black female | 1.78 | 2.39 | 2.73 | 1.93 | 2.58 | 2.26 | +8 (–25, +54) | +8 (–16, +42) | –17 (–42, +14) |
| White female | 3.49 | 4.80 | 3.99 | 3.79 | 4.94 | 4.07 | +9 (–1, +37) | +3 (–5, +30) | +2 (–8, +27) |
| Black male | 5.91 | 6.78 | 8.16 | 15.25 | 16.52 | 17.87 | +158 (+208, +315) | +144 (+186, +284) | +119 (+145, +250) |
| White male | 14.71 | 16.64 | 16.44 | 18.51 | 19.73 | 19.77 | +26 (+26, +45) | +19 (+18, +37) | +20 (+21, +37) |
| Age 20–24 y | | | | | | | | | |
| Black female | 3.65 | 4.96 | 5.22 | 3.08 | 4.40 | 3.67 | –16 (–58, +8) | –11 (–46, +9) | –30 (–72, –7) |
| White female | 6.09 | 6.91 | 6.95 | 4.11 | 4.80 | 4.60 | –33 (–37, –39) | –31 (–44, –28) | –34 (–48, –33) |
| Black male | 20.00 | 22.38 | 25.38 | 23.96 | 26.04 | 26.76 | +20 (+4, +60) | +16 (+1, +53) | +5 (–14, +38) |
| White male | 27.15 | 28.67 | 30.16 | 27.74 | 28.80 | 29.69 | +2 (–4, +9) | 0 (–5, +7) | –2 (–10, +5) |

*Note.* Rates are per 100000. Numbers in parentheses = 95% confidence interval of percentage change, based on linear regression on annual rates. Numbers in boldface type indicate significant upward or downward linear trends.

[a]Correction A: sex- and race/ethnicity-specific corrected estimate, based on Phillips and Ruth[13] (suicide rate + % of specific accidental death and undetermined injury death rates): Black females (18%), White females (11%), Black males (10%), and White males (6%).

[b]Correction B: corrected estimate: suicide rates + undetermined injury death rates.

nicity, females (Figure 1A) had much lower rates compared with males (Figure 1B). Females' rates reflect a downward trend for ages 20 to 24 and a weaker tendency toward higher rates in more recent years for ages 10 to 14 (Figure 1A). A peak of suicide rates in Black females of all age groups and in White females aged 15 to 19 can be observed during the years 1987 to 1989. A less marked peak, limited to Black females, occurred in 1983.

Figure 1B shows that over the entire period, suicide rates for Black males were lower than those for White males. Since 1979, younger males showed an increase in suicides, with a much steeper increase for Black males, leading to similar rates for young White and Black males in more recent years. Suicide rates in young adult males (aged 20–24 years) have varied only slightly over the last 2 decades. For Black males aged 20 to 24 years, a peak in suicide mortality similar to that for Black females occurred in 1989. We can assume observable random variation of mortality rates, especially in the case of very low death counts. However, the finding of these more significant peaks that were limited to the Black population was not expected. It is beyond the scope of this report to examine these nonrandom yearly changes in rates in more detail.

Table 1 shows age- and race/ethnicity-specific rates and trends based on official and corrected numbers. Differences between official and corrected suicide rates were most important in younger age groups and in Blacks. When corrected estimates were used, differences between Black and White adolescent suicide rates tended to diminish. Both methods of accounting for misclassified suicides led to a marked upward correction in rates for most groups. However, as reported in the last column of Table 1, officially reported upward trends of suicide were downwardly corrected on the basis of our estimates. Both corrected estimates led to a downward correction of the percentage of change in all subgroups. The most important downward revision occurred for Black males aged 10 to 14 and 15 to 19 years. Trends in other sex-, race/ethnicity-, and age-specific groups were less affected by misclassification.

The reported confidence intervals for percentage change support an upward linear trend in corrected suicide rates for Black males and all Whites aged 10 to 14 and for Black and White males aged 15 to 19. The observed decrease in rates in White females aged 20 to 24 is supported by a significant linear downward trend for both estimates. Downward trends in Black females and upward trends in Black males aged 20 to 24 years are supported in only 1 of both correction estimates.

## *Discussion*

Adolescents with similar risk factors commit suicide, die from accidents, or become homicide victims. In studies of suicide risks in specific populations, these death categories are potential sources of misclassified suicides and competing causes of death. Our results showed that correction of official suicide rates by estimates of misclassification did have different effects on rates and trends, depending on birth cohort, age, sex, and race/ethnicity. As expected, suicide rates need to be upwardly corrected, especially for younger age groups and for Black adolescents. The need for upward correction can be explained by an important proportion of undetermined or accidental deaths in these populations.

Changes in nonrandom misclassification over time affect suicide trends in a different direction, as shown by our data. Accounting for misclassification leads to downward correction of the 1979 to 1994 trends, especially in Black males aged 10 to 14 and 15 to 19 years. An increase in reported suicides during this period was not accompanied by a corresponding increase in reported undetermined and specific accidental deaths. Higher rates of undetermined deaths in Blacks and a significant decrease in accident death rates in Whites are responsible for the diminished differences in the corrected rates between these 2 groups. We conclude that misallocation of suicides into other death categories decreased between 1979 and 1994, affecting the validity of suicide trends more markedly in groups with traditionally higher portions of accidental and undetermined death. The validity of official suicide trends in young adults and older adolescents seems to be less affected by misclassification.

Our results provide only partial support for the work of other investigators who concluded that a decrease in misclassification accounts for the observed increase in suicide rates in young Black males.[17] We found a significant effect of misclassification on rates (underestimated suicide rates) and on trends (overestimation of trends in young age groups, especially young Black males). However, the direction of trends in official suicide rates between 1979 and 1994 was not significantly altered by misclassification. The increase in suicide rates for male adolescents aged 15 to 19 years and for most subgroups of adolescents aged 10 to 14 years was supported after correcting for misclassification.

The applied methods are not accurate enough for estimates of true suicide rates. Our estimated percentage of misclassified suicides in other death categories was based on investigations of adults. Age might affect both the level of and the change in misclassification over time. Our second estimate did not consider possible changes in sex- and race/ethnicity-specific proportions of misclassified suicides in other death categories. The inability to disentangle real changes in nonsuicidal accident death rates from changes in misallocation of suicides is another limitation of our study. However, the ability to show similar effects through 2 different estimates (1 using only undetermined deaths) supports our results.

The effect of misclassification might be less significant if we were more interested in trends than in rates of suicides. Nevertheless, changes in misclassification over time, as shown for the transition from *ICD-7* to *ICD-8,* can have significant effects on mortality trends. Given the importance of official rates of rare but severe events such as suicides, trends in these rates should be validated. Unfortunately, research is still lacking on the validity of suicide trends in populations at high risk for accidental and undetermined death. Official suicide rates and trends in young Black populations with high rates of undetermined and accidental death and high rates of competing causes of death (homicide) do not seem to reflect real rates and trends sufficiently. Even though our analysis supports the crude validity of the direction of officially reported suicide trends, we conclude that the effects of misclassification on suicide, and the effects of competing causes of death on suicide risk in children and adolescents, should be investigated in more detail. Only more accurate estimates of true suicide rates and trends will serve as valid indicators of mental and social health in adolescent populations. □

## Contributors

B. Mohler planned the study, analyzed the data, and wrote the paper. F. Earls contributed substantially to the conception of the study and the writing of the paper.

## Acknowledgments

Supported by Swiss National Science Foundation grant 3233-47725.96 (B.M.) and by the John D. and Catherine T. MacArthur Foundation (F.E.).

## References

1. *Suicide in the United States 1980–1992*. Atlanta, Ga: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 1995. Violence Surveillance Summary Series, No. 1.
2. Sells CW, Blum RW. Morbidity and mortality among US adolescents: an overview of data and trends. *Am J Public Health*. 1996;86: 513–519.
3. Singh GK, Yu SM. Trends and differentials in adolescent and young adult mortality in the United States, 1950 through 1993. *Am J Public Health.* 1996;86:560–564.
4. Holinger PC, Offer D, Barter JT, Bell CC. *Suicide and Homicide Among Adolescents*. New York, NY: Guilford Press; 1994.
5. Shaffer D, Gould M, Hicks RC. Worsening suicide rates in black teenagers. *Am J Psychiatry.* 1994;151:1810–1812.
6. Centers for Disease Control and Prevention. Suicide among black youth. *MMWR Morb Mortal Wkly Rep.* 1998;47:193–196.
7. Brugha T, Walsh D. Suicide past and present—the temporal constancy of under-reporting. *Br J Psychiatry.* 1978;132:177–179.
8. Holding TA, Barraclough BM. Undetermined deaths—suicide or accident? *Br J Psychiatry.* 1978;133:542–549.
9. Cooper PN, Milroy CM. The coroner's system and under-reporting of suicide. *Med Sci Law.* 1995;35:319–326.
10. Speechley M, Stavraky KM. The adequacy of suicide statistics for use in epidemiology and public health. *Can J Public Health.* 1991;82: 38–42.
11. Neeleman J, Mak V, Wessely S. Suicide by age, ethnic group, coroner's verdicts and country of birth. *Br J Psychiatry.* 1997;171:463–467.
12. Warshauer ME, Monk M. Problems in suicide statistics for whites and blacks. *Am J Public Health.* 1978;68:383–388.
13. Phillips DP, Ruth TE. Adequacy of official suicide statistics for scientific research and public policy. *Suicide Life Threat Behav.* 1993;23: 307–319.
14. Moyer LA, Boyle CA, Pollock DA. Validity of death certificates for injury related causes of death. *Am J Epidemiol.* 1989;130: 1024–1032.
15. *International Classification of Diseases, 7th Revision.* Geneva, Switzerland: World Health Organization; 1957.
16. *International Classification of Diseases, 8th Revision.* Geneva, Switzerland: World Health Organization; 1967.
17. Males M. California's suicide decline, 1970–1990. *Suicide Life Threat Behav.* 1994;24: 24–37.
18. Ohberg A, Pentilla A, Lonnqvist J. Driver suicides. *Br J Psychiatry*. 1997;171:468–472.
19. Shepherd G, Klein-Schwartz W. Accidental and suicidal adolescent poisoning deaths in the United States, 1979–1994. *Arch Pediatr Adolesc Med*. 1998;152:1181–1185.
20. Lester D. Time-series analysis of suicidal and undetermined deaths. *Percept Mot Skills*. 1997; 85(3 pt 2):1242.
21. *International Classification of Diseases, 9th Revision.* Geneva, Switzerland: World Health Organization; 1980.